

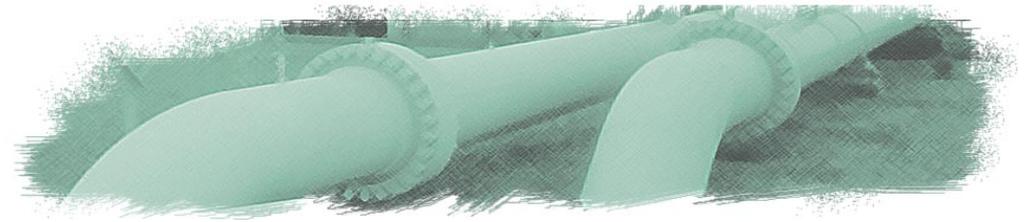
An Overview of PRCI's Research Program

Christina Sames
Pipeline Research Council International, Inc.
API 2004 Pipeline Conference



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Technology for Energy Pipelines



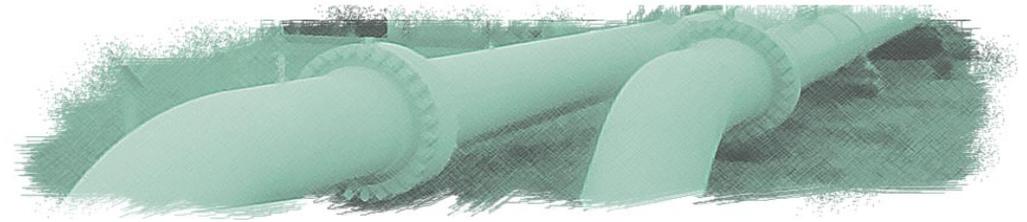
Today's Briefing

- ➔ **Overview of PRCI**
- ➔ **2003/2004 Focus**
- ➔ **Project Highlights**
- ➔ **Future Focus**



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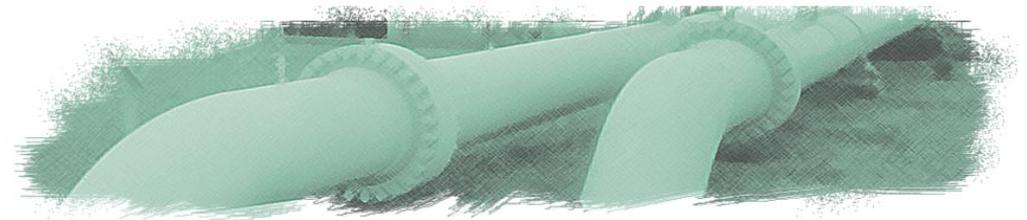
Pipeline Research Council International, Inc. (PRCI)

**A collaborative technology
development organization
Of, By, and For
the energy pipeline industry**



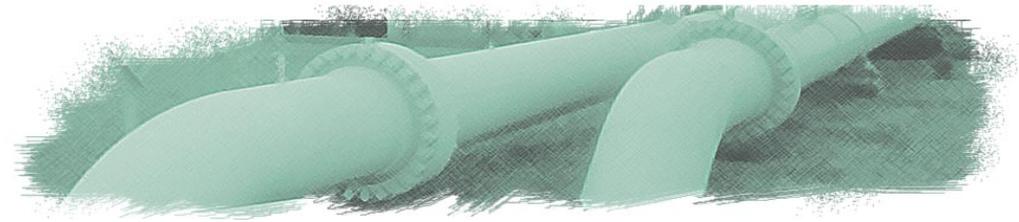
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A PRCI Snapshot

- ➔ Established in 1952 by 15 North American natural gas companies to address long-running brittle fractures.**
- ➔ Not-for-profit corporation since 2000**
- ➔ Current membership:**
 - 33 national & international pipeline companies**
 - 300,000 miles of natural gas & hazardous liquid pipelines**
 - AOPL**
 - GTI**



Who We Are



EXPLORER PIPELINE COMPANY



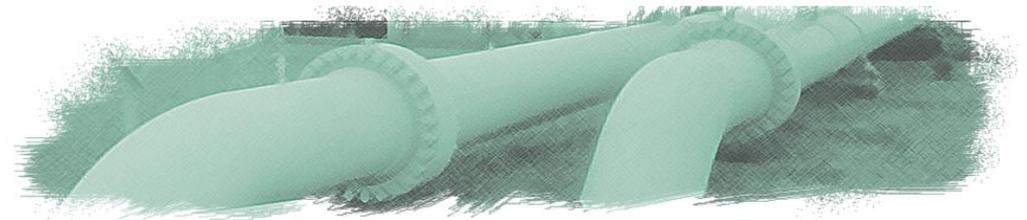
Buckeye Partners, L.P.





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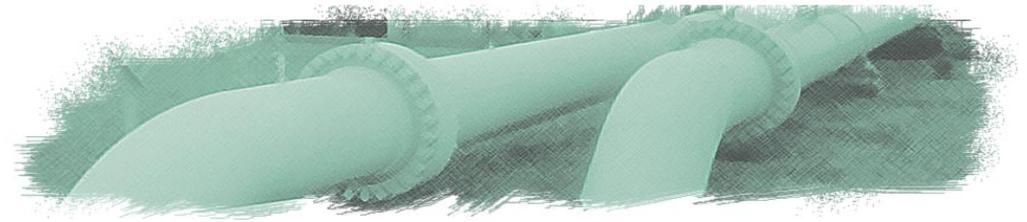
How Does it Work?

- ➔ Pipeline member technical experts plan & manage the technical agenda**
- ➔ One Member/One-Vote on the Board & Technical Committees**
- ➔ Members Have Free Access to All PRCI Technology**
- ➔ More Than \$185MM Contributed Since 1952**



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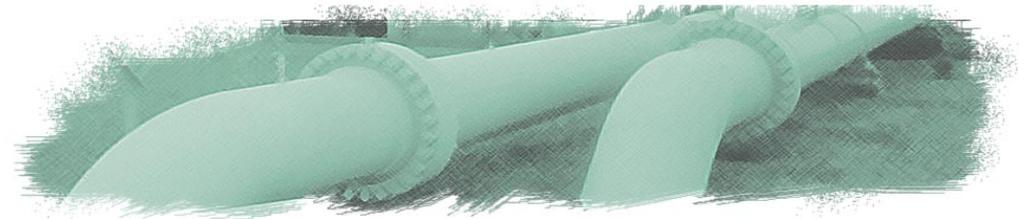
PRCI Technical Committees

- ➔ **Corrosion and Inspection**
- ➔ **Design, Construction, and Operations**
- ➔ **Materials**
- ➔ **Measurement**
- ➔ **Underground Storage**
- ➔ **Compressor and Pump Station**



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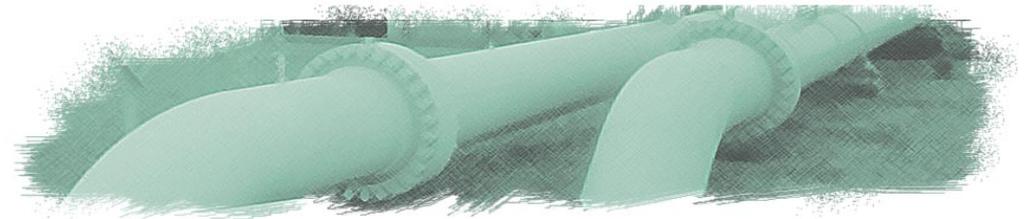
R&D Budgets

<u>Program (\$MM)</u>	<u>2003</u>	<u>Co-fund</u>	<u>2004</u>	<u>Co-funds</u>
Design, Const. & Ops.	\$1.6MM	\$1.0MM	\$2.0MM	\$1.5MM
Materials	3.0	0.6	3.0	1.8
Corrosion & Inspect	3.8	0.5	3.7	3.1
Compressor & Pump	1.4	1.9	1.3	0.9
Underground Storage	0.6	0.7	1.0	1.5
Measurement	<u>0.7</u>	<u>0.3</u>	<u>1.0</u>	<u>0.4</u>
Total	\$11.1MM	\$5.0MM	\$12MM	\$9.2MM
	2003 total \$16.1MM		2004 total \$21.2MM	



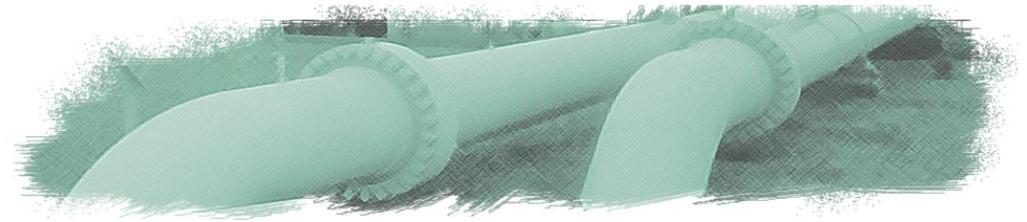
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PRCI Committees

- **Corrosion and Inspection**
 - ILI for mechanical damage, cracks, & geometry, direct assessment, coatings & inspection tools, SCC, MIC
- **Design Construction and Operations**
 - Implementing new integrity standards, reliability based design, preventing 3rd party damage, human factors, abnormal external loads, wrinkles/ripples
- **Materials**
 - Stronger steels, (X100 and beyond), repair & assessment tools, new welding and inspection processes, processes to lower construction costs



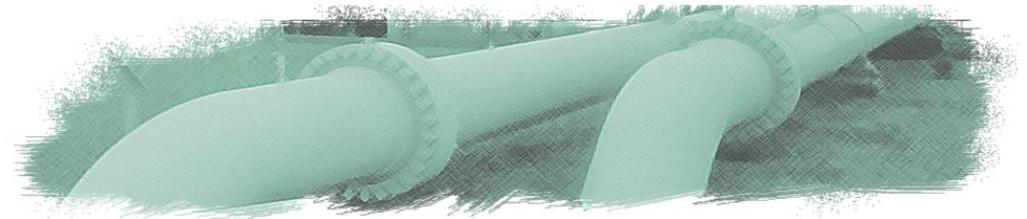
PRCI Committees

- **Compressor and Pump Stations**
 - Flexibility, Life Extension & Reliability, Engine Efficiency and Environmental Compliance
- **Measurement and Metering**
 - Reliability and Accuracy, Wet Gas Solutions, Product/Pipe Compatibility and Integrity
- **Underground Storage**
 - Cavern Safety, Productivity, & Deliverability
 - Cavern Expansion



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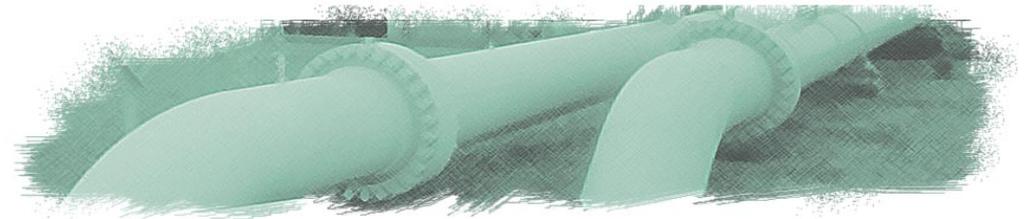
Corrosion and Inspection Programs

- ➔ **7 Programs, ~ \$11MM in 2003/04**
 - Locate Mechanical Damage
 - Enhance Integrity of Non-piggable Pipelines
 - Protect Shielded Pipe and Enhance Environmental Corrosivity Models
 - Identify and Prioritize Locations for Internal Corrosion Inspection, Monitoring, and Mitigation
 - Optimize Integrity Assessment Intervals
 - Improve SCC detection, assessment and management
 - Improve CP System Effectiveness



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Corrosion and Inspection Projects

➔ Locate Mechanical Damage

- Details of Defect Induces in MFL Signals

Total funding: \$2.2M

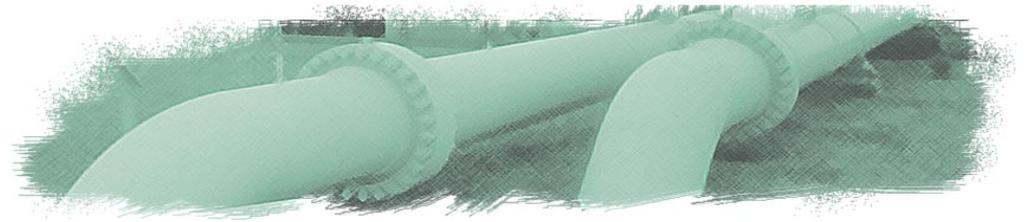
Model MFL signal responses to determine stress fields and detect mechanical damage

Completion: 2005



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Corrosion and Inspection Projects

➔ Improve CP System Effectiveness

- Develop Quantitative Relationships Required to Define Mitigation Levels Necessary to Prevent Corrosion**

Total funding: \$500K

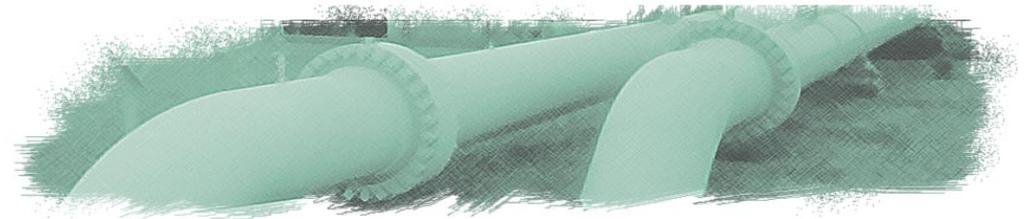
Model distribution paths of AC in confined corridors and suggest mitigation strategies

Completion: 2005



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Design, Construction, and Operation Programs

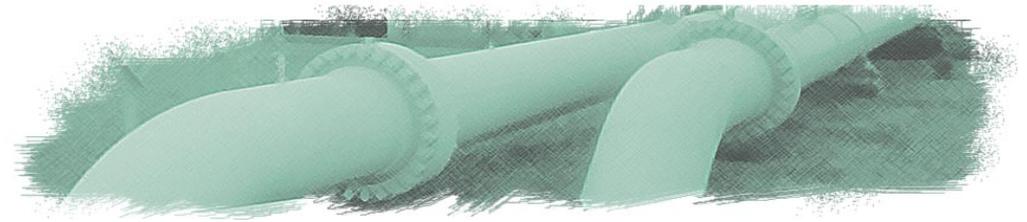
➔ 7 programs and ~ \$6MM in 2003/2004

- Prevention of 3rd party damage
- Implementing integrity standards
- Reliability-based design alternatives
- Determination of maximum safe surface loads
- Leak detection and notification
- Prevention of critical pipeline strains
- Solutions for adverse crossings



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Design, Construction, and Operation Programs

➔ Prevention of 3rd party damage

– Detection & Monitoring:

Develop acoustic monitoring for mechanical damage, satellite imagery for unauthorized encroachment and ground movement, and software to detect changes in radar images

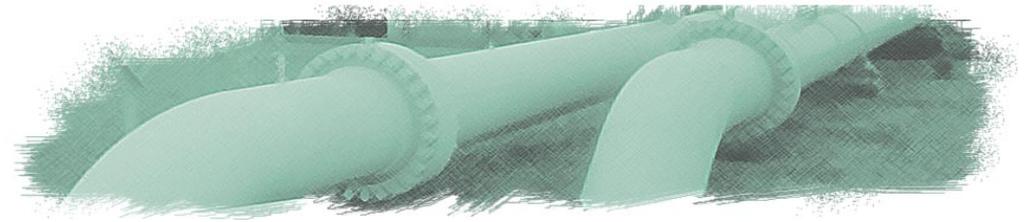
Total funding: \$1.7M

Completion: 2004



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Design, Construction, and Operation Programs

➔ Leak Detection and Notification

– Liquid Release Detection:

Parametric based model to lower the leak detection threshold for liquid pipelines

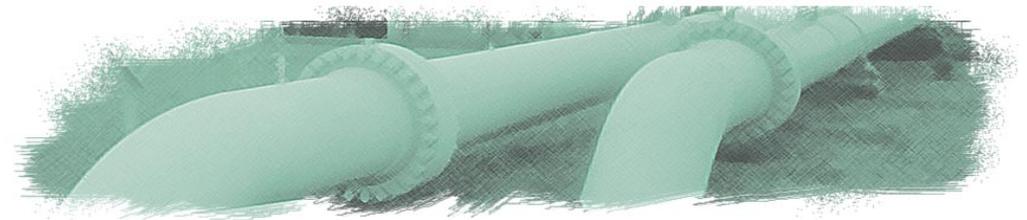
Total funding: \$400K

Completion 2005



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Design, Construction, and Operation Programs

➔ Prevention of Critical Pipeline Strains

- Pipe – Soil Interaction: \$700K in 2003/2004

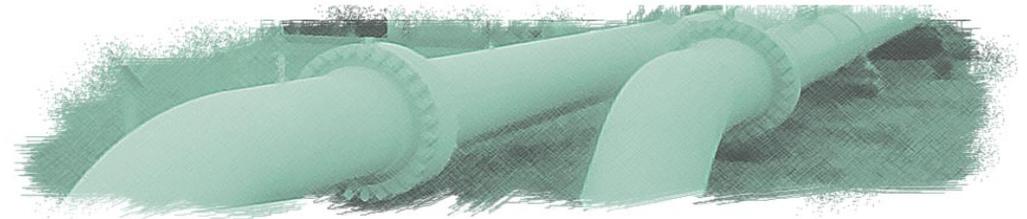
Models and methods for addressing pipe-soil interaction effects in design and mitigation (including frozen soils)

Completion: 2004



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Materials Programs

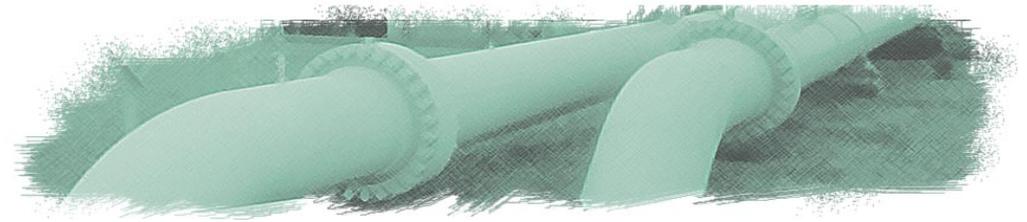
➔ 4 Programs, ~ \$9MM in 2003/04

- Integrity Assessment and Management of in-service damage**
- New Materials and Welding Processes to Lower the Cost of New Pipeline Construction**
- Maintenance Welding Techniques**
- Advanced Material Design, Safety, and Integrity**



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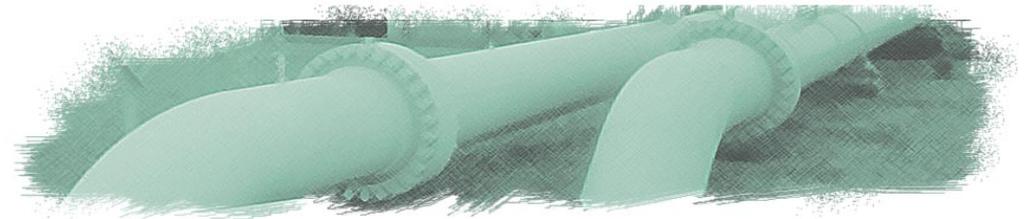
Materials Projects

- ➔ **Integrity Assessment and Management for In-Service Damage**
 - SCC Crack Extension and Coalescence Modeling: Extend the SCC crack growth model to project SCC behavior over time under generalized loading conditions
 - SCC Avoidance in Ethanol Pipelines: Identify the primary factors and range of service conditions likely to cause SCC in ethanol pipelines



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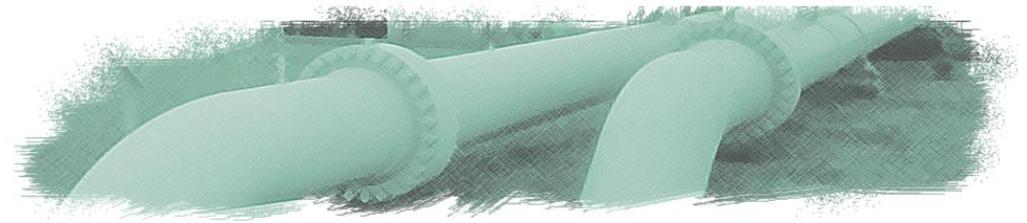
Materials Projects

- ➔ Integrity Assessment and Management for In-Service Damage
 - Assessment of Remaining Strength of Corroded Pipe
- Guidance to assess remaining strength of corroded pipe subject to biaxial & cyclic loading, of corroded higher strength pipe (x80/100), & failure pressure of corrosion defects in low toughness pipe
- Total funding \$400K
- Completion 2005



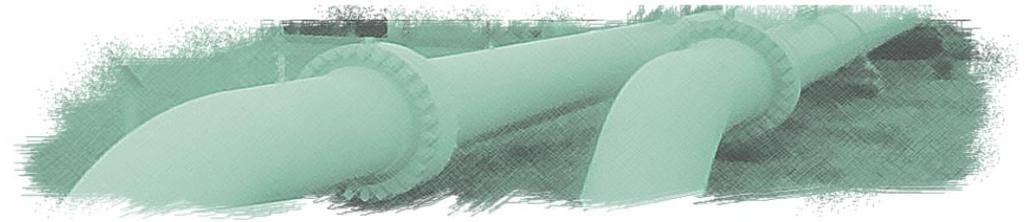
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Materials Projects

- ➔ **New Materials and Welding Processes**
 - Improved Welding Methods for Pipelines
 - Multi-wire GMAW procedures for high speed, high deposition fill pass welding
 - Total funding \$500K
 - Completion 2005



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